國立清華大學 102 學年度碩士班考試入學試題

系所班組別：生醫工程與環境科學系 乙組（環境分子科學組）

考試科目（代碼）：環境科學與工程 (2302)

1. What is the oil of the 21st century? What is an easy indicator of the general health of the river? (4%)

2. Identify the water treatment process (from the list below) that is most likely to be used to: (6%)

   i) protect the general public from dental caries -

   ii) remove turbidity -

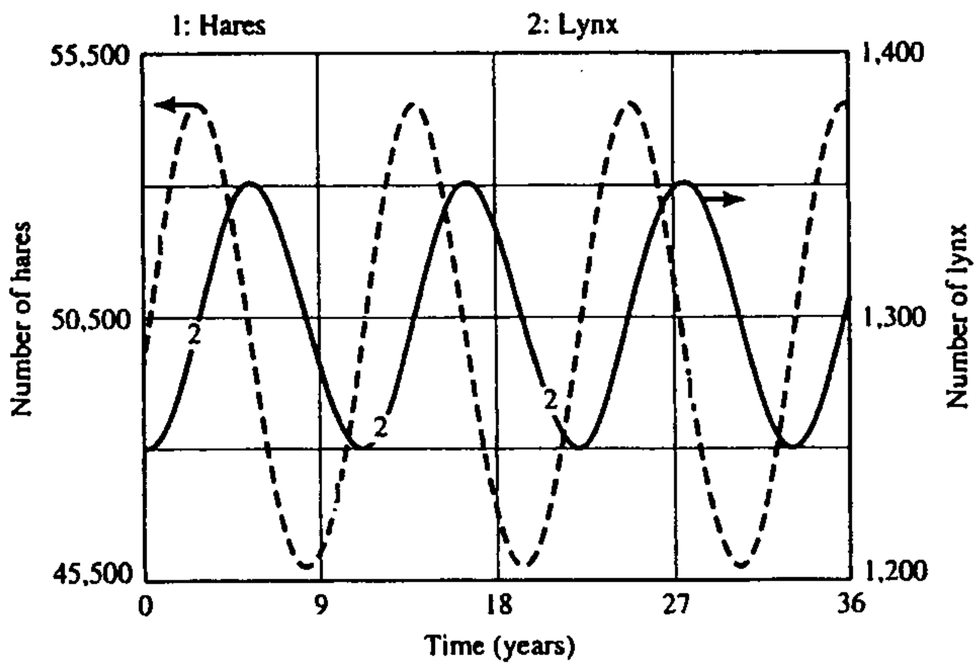
   iii) reduce the pH following softening -

A) softening	B) flocculation/ coagulation	C) alkali addition
D) recarbonation	E) disinfection	F) bar screens
G) low-lift pumps	H) high lift pumps	I) fluoridation
J) distribution	K) filtration	L) activated sludge

3. Compare and explain the toxicity of ammonia with that of ammonium ion to fish? Choose one method for the determination of ammonium ion in seawater and describe briefly its principle and how it works. (20%)

4. You have just been hired by the Taiwan EPA. One of your first assignments has been to develop a treatment standard for the toxic chemical known as greenplasticizer. You are to set the MCL for drinking water at a level that will achieve a lifetime risk of 10^{-7} for an adult. You are to assume that the average adult drinks this water for half of their life, weighs 70 kg, drinks 2 L water/day and has a life expectancy of 70 years. The oral potency factor for greenplasticizer is 1.3×10^{-3} $(mg/kg/day)^{-1}$. At what level (μg/L) should the MCL be set? (20%)

5. The Lotka-Volterra model has been successfully applied to the periodic nature of predator-prey relationships in ecology as shown below. Write down two differential equations to describe the numbers of predator (lynx), K, and prey (hares), P, with four constants (a: growth rate of the prey, b: mortality parameter of the prey, c: growth rate of the predator, and d: mortality parameter of the predator). Derive the cyclic variations of predator and prey, rather than exponential decay. (20%)



6. (a) Define the retardation coefficient, R, and derive the retardation coefficient of a typical organic contaminant in groundwater. Express the retardation coefficient with bulk density of the soil (ρ_b), porosity of the soil (η), fraction of organic carbon in the soil (f_{oc}), partition coefficient into the organic carbon fraction of the soil (K_{oc}), and any other physical constants. By definition, the partition coefficient describing sorption equilibrium of a chemical-distribution ratio, $K_d = C_s/C_{aq}$. C_s and C_{aq} are the equilibrium concentrations of the chemical in the water and on the soil, respectively.

(b) For an aquifer solid with a bulk density of 2 g/cm^3 containing 0.5% organic carbon, estimate the retardation factor for the common polycyclic aromatic hydrocarbon (PAH) naphthalene ($C_{10}H_8$), used in mothballs. The partition coefficient of naphthalene into the organic carbon fraction of the soil (K_{oc}) is 1400ml water/g carbon. If the porosity of the aquifer is 0.24, hydraulic conductivity is 10^{-3} cm/sec, and the hydraulic gradient is 0.01, how fast will a plume of naphthalene travel? (30%)